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NAVAL SURFACE WEAPONS CENTER TECHNOLOGY TRANSFER
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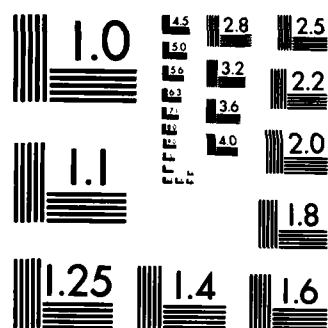
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BY RAMSEY D. JOHNSON

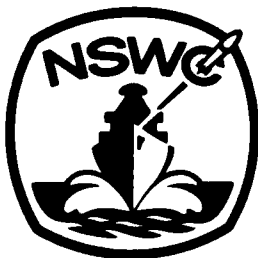
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report describes the Naval Surface Weapons Center Technology Transfer Program and presents narrative summaries of related projects performed during FY83/84. Technology Application Assessments and a listing of patents/Navy cases for this time period are also presented.		

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FOREWORD

The Naval Surface Weapons Center (NSWC) Technology Transfer Biennial Report (FY83/84) has been prepared in accordance with the format and content currently specified by the Chief of Naval Material for Navy inputs in meeting the reporting requirements of the Stevenson-Wydler Technology Innovation Act of 1980 (Public Law 96-480).

The objectives of Navy technology transfer are (1) to disseminate non-critical technology, originally developed in support of military applications, for potentially alternative uses in the public and private sectors; and (2) to promote joint cooperative development programs that address problems of mutual concern to the Navy and other agencies or organizations. In pursuit of these objectives, the Navy transfers technical expertise to other Federal Government agencies; state and local governments; small and large businesses; nonprofit organizations; and such public service organizations as schools, hospitals, and foundations. In addition, technologies that have direct impact on the Navy mission and programs are transferred within, or into, the Navy. Transfers of hardware, software, management practices, and expertise are made in diverse fields, such as analysis and testing, communications, energy, environment, transportation, and marine technology. The Navy Technology Transfer Program provides unique services not available from the private sector and not in competition with that sector. The underlying philosophy and approach is to promote domestic technology transfer activities of non-militarily critical technical material that is approved for public release.

A substantial portion of the information in the Appendices of this report was contributed by NSWC technical staff members engaged in Center technology transfer tasks. Questions or requests for additional information should be referred to NSWC, Code D21, Mr. Ramsey D. Johnson, (301)394-1505 or Autovon 290-1505.

Approved by:

D. N. Dick

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Advanced Planning Staff

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1. ORGANIZATIONAL STRUCTURE FOR TECHNOLOGY TRANSFER

a. Background. From a historical perspective, NSWC has been involved in technology transfer activities even prior to participating as a charter member of the Department of Defense Technology Transfer Consortium in 1971. This organization subsequently evolved into the Federal Laboratory Consortium, of which NSWC continues to be a contributing member. NSWC's role is necessarily limited since its R&D efforts are principally directed towards Navy requirements in the national security arena. Consequently, considerations of security classification and export control of unclassified critical technologies can severely constrain the release of technical information on an unrestricted basis. Furthermore, the work is often intrinsically oriented to naval applications, and considerable adaptive engineering (necessitating non-DoD funding sources and redirection of in-house resource allocations from mission areas) would be required to redirect the R&D to non-Navy uses. Within these general constraints, NSWC endorses and pursues technology transfer activities involving Center-wide R&D efforts.

b. Program Implementation

(1) Management. The Center's domestic technology transfer policy is administered by the Advanced Planning Staff (Code D21). The staff provides advanced planning information on matters impacting the role, mission, and long-term commitments of the Center. Policy implementation vehicles for technology transfer include the Center's Office of Research and Technology Applications (ORTA), the Navy/Industry Cooperative Research and Development (NICRAD) Program, and the Federal Laboratory Consortium for Technology Transfer. The Industry Independent Research and Development (IR&D) Program is an informal contributor to technology transfer activities, since the transfer process can involve a two-way exchange between government and non-government organizations. The IR&D Program serves to inform government technologists about industry-initiated research and development projects of interest and applicability to the Department of Defense. Technology transfer management functions include:

- (a) coordinating the program within the Center;
- (b) maintaining external liaison (with the Chief of Naval Material, the Federal Laboratory Consortium for Technology Transfer, the Department of Commerce, other Federal agencies, state and local governments, universities, and private industry);
- (c) preparing Technology Application Assessments;
- (d) assisting potential user organizations in formulating their problems;
- (e) providing and disseminating information on federally owned or originated products, processes, and services having potential application to state and local governments and private industry; and

(f) providing technical assistance in response to requests from state and local governments.

(2) Technical Effort

(a) Project Work. Directly attributable and quantifiable technology transfer work performed by Center technical departments is generally represented by those projects funded by other Government (non-DoD) sponsors and private parties (excluding that effort funded by DoD contractors). This type of effort has manpower and funding allocations which are directed towards a specific objective or requirement per sponsor request.

(b) Technological Disclosures. In its role as a major Government R&D center, NSWC also serves as a significant contributor to Federal technology transfer in a more generic nature via technological disclosures in the open literature such as patents, reports, journals, and participation in symposia. The benefits from this type of activity accrete as spin-offs from DoD mission-related projects which are supported by Federal R&D appropriations. Although it is less tangibly measurable than technology transfer contributions of direct project work involving end-products, the long-term benefits are more highly promising since they provide the innovative community with a broad spectrum of new stimuli to promote economic, technical, and quality-of-life growth in the private and public sectors.

(3) Navy-wide Services. The Center also manages, edits, and publishes the "Navy Technology Transfer Fact Sheet." This monthly publication highlights Navy-wide technology and developments that have the appropriate approval for public release and are of potential benefit to public and private organizations, individuals, and other Federal laboratories. The program is sponsored by the Chief of Naval Material (MAT-081) to provide a highly visible source and focus for the dissemination of domestic technology transfer contributions from the Navy laboratory community.

c. Program Funding Source. A summary of FY83 and FY84 funding support for management activities and projected work performed by the Center technical departments is presented below:

	<u>FY83 (\$K)</u>	<u>FY84 (\$K)</u>
(1) Administrative Functions		
ORTA	20	25
Other Technology Transfer	15	15
Technical Publications Division	105	96
(2) Technical Projects		
Engineering Department	6	5
Electronics Systems Department	174	300
Weapons Systems Department	425	251
Strategic Systems Department	179	10
Research and Technology Department	182	508
Underwater Systems Department	<u>508</u>	<u>236</u>
Total	1624	1446

d. The following technology transfer policy directives are in effect at NSWC:

(1) NAVSWCINST 5700.2 of 23 July 1982; Subj: Office of Research and Technology Applications (ORTA). The purpose of this instruction is to establish the Center ORTA.

(2) NAVSWCINST 3900.1A of 22 December 1981; Subj: Navy/Industry Cooperative Research and Development (NICRAD) Program. The purpose of this instruction is to establish procedures for processing NICRAD agreements in accordance with NAVMATINST 3900.14. The NICRAD Program is technically not an element of the Navy's Domestic Technology Transfer Program. Frequently, it involves the exchange of sensitive and classified information to authorized contractors. Nevertheless, transfer to technology is involved. Therefore, for administrative purposes this program is included as a functional element of the NSWC Technology Transfer Program.

e. The Center point-of-contact for ORTA and the NICRAD program is Mr. Ramsey D. Johnson, Code D21, (301)394-1505 or Autovon 290-1505.

2. ACCOMPLISHMENTS AND CURRENT EFFORTS SUMMARY

a. Narrative summaries of NSWC technology transfer related projects involving FY83 and FY84 effort are presented in Appendix A.

b. The following reports, which describe recent Center accomplishments and efforts, were published for public release:

(1) NSWC MP 82-468, Naval Surface Weapons Center Technology Transfer Biennial Report (FY81/82).

(2) NSWC MP 84-38, Naval Surface Weapons Center Technology Transfer Report (FY83).

c. For FY83/84 period, nine Technology Application Assessments were submitted to the Department of Commerce, National Technical Information Service. These items are presented in Appendix B and are listed below:

- (1) Electronic Thermostat
- (2) Magnetomechanical Transducer
- (3) MHD Analogy Instrument
- (4) Hydraulic Analogy Test Instrument
- (5) Radiographic Nondestructive Evaluation
- (6) Lightweight Nickel Electrodes
- (7) Eddy Current Non-Destructive Inspection of Graphite Epoxy
- (8) Seismic Enhancements in NASTRAN
- (9) Surface Roughness Technique

3. INFORMATION DISSEMINATION AND WORKING RELATIONSHIPS

a. NSWC is a member of the Federal Laboratory Consortium for Technology Transfer and participates in meetings, symposia, and exhibits related to technology transfer activities involving the Navy, state and local governments, and private industry.

b. NSWC publishes the "Navy Technology Transfer Fact Sheet." FY83 and FY84 inputs to this document are listed below:

- (1) Program Makes Major Advance in Li/SO₂ Reserve Battery Development
- (2) NSWC Assumes Lead Role in Lithium Battery Safety
- (3) International Group Compiles Earth's Polar Motion Values
- (4) Environmentalist Aids County in Building Retrofit
- (5) Eddy Current Technology Extends to Graphite Epoxies
- (6) Magnetohydrodynamic Analogy Instrument Tests Supersonic Flows
- (7) Battery Grid for Submarines May Have Industrial Uses
- (8) New Cable Connector Invented to Join Fiber Optic Cables
- (9) Ball Bearing Assembly Device Developed
- (10) New Hydraulic Analogy Instrument Tests Gasdynamic Flows

c. NSWC participated in the following significant Technology Transfer functions:

- (1) Conference: Government-Industry Technology Transfer Conference
Sponsor: Federal Laboratory Consortium for Technology Transfer
Date: 8, 9 February 1983
Place: Baltimore, MD
Comment: The purpose was to provide industry with information about Government-developed technology and engineering innovations that have the potential for commercialization. Participants included representatives of 10 government activities and 23 private companies.

(2) Meeting: In September 1983, NSWC hosted a progress and planning meeting for representatives from participating agencies in the Federal Laboratory Technical Volunteer Service (TVS). The agenda included a training session for TVS coordinators.

(3) Conference: In August 1984, NSWC participated in the "Opportunities Through Technology Transfer" conference at Allegheny College in Meadville, Pennsylvania. This conference supported the Meadville Area Industrial Commission in an advanced technology awareness and adaptation program structured to enhance the competitive posture of businesses and industries in Meadville and the surrounding Crawford County, Pennsylvania area.

- (4) Manufacturing Technology Review: Titanium Manufacture and Fabrication
Sponsor: Naval Sea Systems Command
Date: 13 January 1983
Place: Niles, OH

- (5) End-of-Project Technology Transfer Demonstration: Electronic Level Sensor and Indicating System

Sponsor: Naval Sea Systems Command

Date: 13 April 1983

Place: Kansas City, MO

- (6) End-of-Project Technology Transfer Demonstration: Graphite Aluminum Tape and Tooling

Sponsor: Naval Sea Systems Command

Dates: 8 March and 25 April 1983

Places: Chatsworth, CA and Columbus, OH

- (7) Presentation on Carbon-Carbon Manufacturing Technology Program for Thin-Wall Shapes

Sponsor: Naval Material Command

Dates: 12 April 1984

Place: Washington, DC

d. NSWC entered into the following 27 NICRAD Program Policy Agreements in FY83 and FY84:

<u>COMPANY</u>	<u>PROJECT TITLE</u>	<u>EFFECTIVE DATES</u>
(1) Sanders Associates, Inc.	Advanced Ascent Mine Acoustic Studies	2/83 to 12/85
(2) MariPro/Science Applications, Inc.	Passive Detection Studies	2/83 to 11/85
(3) Aerojet Ordnance Co.	Study of Penetrator Materials and Configurations to Defeat Close-In Threat	3/83 to 2/86
(4) Gould Defense Systems, Inc.	Charged Particle Beam Weaponization Study	3/83 to 3/86
(5) Brimrose Corporation of America	Manufacture of Far Infrared Multicolor Epitaxial Pb Alloy Detectors	4/83 to 3/86
(6) FMC Corporation	Carrier Battle Group Simulation Modeling	4/83 to 3/86
(7) General Research Corp.	Passive Acoustic Detection Systems Study	5/83 to 5/85

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(8)	AAI Corporation	Microwave Expendable Decoy	6/83 to 2/86
(9)	Martin Marietta Corp.	Sea Control Missile Requirements and Technology Study	6/83 to 5/86
(10)	RCA Corporation	Pyrophoric Sensor Technology for Physical Security Systems	7/83 to 6/86
(11)	Directed Technologies, Inc.	Naval Applications of Particle Beam Weapons	10/83 to 9/86
(12)	Aerojet Liquid Rocket Co. (Navy Weapons Division)	New Mine Concepts	12/83 to 11/86
(13)	Lockheed Electronics Co., Inc.	Local Defense Surveillance and Weapon Control	12/83 to 11/86
(14)	Optical Technologies, Inc.	Fiber Optic Sensor Study	12/83 to 11/86
(15)	CACI, Inc.-Federal	Navy Weapons Systems R&D Requirements Study	12/83 to 11/86
(16)	FMC Corporation (Northern Ordnance Div.)	Artificial Intelligence Applied to a Military Battle Management System	3/84 to 1/87
(17)	Shenandoah Systems Co., Inc.	Mine Warfare Requirements	1/84 to 12/86
(18)	Bendix Corporation (Oceanics Division)	ASW Deep Moor Mine	1/84 to 9/86
(19)	Hazeltine Corporation (Electro-Acoustic Systems Lab)	Broadband Detector Performance Evaluation	3/84 to 10/85
(20)	Goodyear Aerospace Corp.	Target Motion Analysis/ Minefield Effectiveness	4/84 to 3/87

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(21)	Martin Marietta Aerospace	Particle Beam Antiship Missile Defense	6/84 to 5/87
(22)	Gould, Inc. (Defense Electronics Div.)	Mine Detection and Localization Studies	6/84 to 5/87
(23)	Lockheed Electronics Co., Inc.	Remote Interface Unit	8/84 to 7/87
(24)	Gould Defense Systems, Inc. (Ocean Systems Division)	Lithium Metal Sulphide (Li/Ms) Secondary Batteries	8/84 to 7/87
(25)	Lockheed Advanced Marine Systems	Mine Technology	9/84 to 8/87
(26)	Sippican Ocean Systems, Inc.	Mine Sensor Technology	9/84 to 8/87
(27)	Project Engineering, Inc.	Navy R&D Requirements Study	9/84 to 8/87

e. Inventions and patent disclosures by NSWC in FY83 and FY84 totaled 58. These are listed in Appendix C.

f. In support of state and local governments and academic institutions, the NSWC ORTA responded to requests for technical information from the following organizations:

- (1) Oregon State Police (night and foul weather observation devices)
- (2) California Department of Corrections/American Justice Institute (contraband detection and interdiction)
- (3) Elk City, Oklahoma (NITINOL information for potential local business ventures)
- (4) California State University (liquid metallic jet metal cutting)
- (5) University of Arkansas (Li/SO₂ battery development)
- (6) Oregon State University (magnetostrictive materials)

g. The NSWC ORTA responded to technical information requests from private industry in the following technology areas:

- (1) Eddy current technology for graphite epoxies
- (2) Fiber optics cable connector
- (3) Li/SO₂ reserve battery
- (4) NITINOL (shape-memory alloys)
- (5) Magnetostrictive transducer
- (6) Computer cross-tie memory
- (7) Metal matrix composite materials
- (8) Luminescent lighting

Numerous inquiries are made directly to Center staff members within the various technical departments. The resultant responses significantly contribute to the Center's technology transfer process, although they are not formalized within the ORTA function.

APPENDIX A

NARRATIVE SUMMARIES FOR NSWC FY83/84 TECHNOLOGY
TRANSFER RELATED PROJECTS

1. MANUFACTURING TECHNOLOGY

a. The Navy Manufacturing Technology Program requires that technology transfer to the private sector and Government agencies be a major activity of each funded project. Accordingly, upon completion each project is required to have an end-of-project demonstration for potential users or vendors, and to issue a final report. In both instances, efforts are made to disseminate the information to the widest possible audience. However, some of the information is classified and some is unclassified but associated with critical, sensitive technologies. This information is not releasable for public information and such requests are individually assessed regarding the extent to which information may be disseminated. Within this constraint each project manager is encouraged to actively communicate with interested parties during the project to transfer the developing technology.

b. In addition to technical project work, NSWC also provides technical and administrative program support offices to the Naval Sea Systems Command (NAVSEA) for manufacturing technology programs in combat systems and robotics. In FY83 and FY84, NSWC and NAVSEA participated in the following projects:

- (1) Review of Titanium Manufacture and Fabrication
- (2) End-of-Project Demonstration for Graphite Aluminum Tape and Tooling
- (3) End-of-Project Demonstration for Electronic Level Sensor and Indicating System
- (4) Presentation on Carbon-Carbon Manufacturing Technology Program for Thin-Wall Shapes

c. The following Manufacturing Technology programs are on-going at NSWC:

- (1) Graphite-aluminum tape and tooling
- (2) Advanced neutron radiography
- (3) Multicolor epitaxial thin-film infrared detectors
- (4) Reinforced lead acid battery grids
- (5) Passive 3-D vision for robotic applications

- (6) Liquid metal infiltration process development
- (7) Metal Matrix Composite
 - (a) secondary fabrication process development
 - (b) billet scale-up
 - (c) extrusion process development
- (8) Process development for production of graphite-metal mill shapes
- (9) Graphite-aluminum thin strip applications

2. U.S. COAST GUARD DIVING EQUIPMENT PROGRAM

The objective of the FY82 and FY83 work was to bring U.S. Coast Guard diving equipment and procedures into conformance with Navy standards. The program consisted of a survey of Coast Guard diving equipment, selection and procurement of approved equipment, and technical support in the operation of the Coast Guard diving program. Emphasis was on the selection and procurement of surface supplied and SCUBA equipment. An air supply system was designed and procured, and a MK 12 diving system was procured for the Coast Guard Strike Force Dive Team. In FY83 and FY84, NSWC provided technical support and consultation in the areas of design, development, and selection of diving equipment and procedures. Additionally, a variety of equipment was procured and delivered to Coast Guard units.

3. SPACE SHUTTLE BOOSTER WATER ENTRY

a. NSWC has supported the National Aeronautics and Space Administration (NASA), Marshall Space Flight Center for several years during Space Shuttle System development. During FY83 and FY84, the support was directed toward solving problems encountered during the recovery phase of the Solid Rocket Boosters (SRBs). Specifically, the objective was to reduce water impact damage. The standard post-launch operational deployment requires the spent boosters to be parachuted nozzle-first into the ocean, followed by recovery for subsequent refurbishment and reuse. However, unexpected structural damage was being sustained during water entry, which resulted in unexpected, additional redeployment costs. NSWC's contributions to the completed effort, which significantly reduced the water impact damage, were as follows:

(1) participated in a Navy Advisory Group to provide expertise and consultation to NASA;

(2) conducted cavity entry tests (47 in FY83 and 30 in FY84) using a 3-foot diameter model in the Hydroballistics Facility under vacuum scaling conditions to measure cavity collapse loads; and

(3) conducted 73 water entry launches of highly instrumented, full-scale sections of the SRB skirt to measure water impact loads.

b. During FY84, NSWC also supported development of a lightweight graphite case for the SRB.

4. SOLID ROCKET BOOSTER (SRB) HAZARD STUDY

NSWC has supported NASA, Marshall Space Flight Center, for many years during the development of the Command Destruct System (CDS). During FY83, the support was directed to investigate the interaction between the CDS - Linear Shaped Charge (LSC) for the SRB during destruct action and the propellant grain with the new carbon-carbon filament wound case design. The objective of this program is to determine the nature of this interaction, the quantity of propellant involved (if any), and the airblast/fragment environment. A progress report has been submitted to NASA that provides: (1) preliminary data on shock loads transmitted to the propellant (simulant) upon destruct action and (2) estimate of airblast/fragment environment should the SRB propellant detonate upon destruct action. This effort is expected to carry through FY85 with LSC destruct tests of SRB case (new filament wound design and old steel design) and propellant materials. Plans also include destruct tests of subscale rocket motors.

5. HYDROBALLISTIC FACILITY

NSWC provides a hydrodynamic testing facility for use by Federal agencies and private industry. The parallelopiped test tank has inside dimensions of 100 feet in length, 35 feet in width, and 75 feet in height. Water depths up to 65 feet are possible while the normal depth is 60 feet. A major feature of the tank is the ability to create a vacuum above the water surface which provides the proper conditions for correct scaling of model tests. Photographs may be taken through the 152 viewing ports located on three sides, and top and bottom of the tank or by existing underwater systems. During FY83 and FY84, test services were supplied to NASA to support the Space Shuttle Program and to a number of contractors who tested several systems.

6. GPS GEODETIC RECEIVER SYSTEM

a. Using the signals from the Global Positioning System (NAVSTAR) Satellites, the GPS Geodetic Receiver System will provide remote realtime point positioning approaching 1 meter accuracy in 4 to 6 hours versus 24 to 36 hours using the Navy Navigation Satellite System (TRANSIT). Relative positioning determination between 2 sites, 100 to 250 kilometers apart, will approach 2 centimeters in accuracy after approximately 4 hours on site, and 4 meter positioning accuracy will be typical when the Receiver System is used on a low dynamic survey vessel or aircraft. These are requirements that the sponsors, Department of Interior (U.S. Geological Survey); Department of Commerce (NOAA-National Geodetic Survey); and Defense Mapping Agency, have placed on the Receiver System. An attractive feature of the Receiver System is its software controllability, offering relatively easy adaptation for either special geodetic or nongeodetic applications.

b. NSWC was selected to direct the Receiver System development due to its previous geodetic work with TRANSIT and continuing work with GPS. In addition, NSWC has developed the first set of fixed position solution software and is integrating it in the hardware.

7. HNS PHOTODECOMPOSITION STUDY

The objective of this work, funded by NASA, Johnson Space Center, was to further characterize HNS explosive and its impurities by determining its sensitivity to undergo photodecomposition and to identify the resultant effects on detonating cord performance. The technical approach involved collecting kinetic data on the rates of photolysis of HNS and HNBiB (the major impurity in the HNS synthesis). NSWC involvement was to:

- a. establish the kinetics of photodecomposition of HNS and HNBiB when carried out in sunlight and in mercury lamp irradiation using borosilicate glassware;
- b. isolate and identify major photoproducts produced from this reaction using techniques such as thin layer chromatography, high performance liquid chromatography, and gas chromatography;
- c. fabricate detonating cords from photolyzed HNS; and
- d. expose specially prepared detonating cords to selected temperatures for performance comparison with non-irradiated HNS cords.

8. FAA ADVANCED AUTOMATION PROGRAM

The Department of Transportation/Federal Aviation Administration (FAA) is in the process of modernizing its computer systems that track and control air traffic in the continental United States. One phase of this program was to develop and initiate the implementation of a plan to assure that the computer systems have sufficient capacity to perform over the life of the system. The plan can be readily adapted to most realtime embedded computer systems. Based on NSWC's experience in the area of capacity management, the FAA funded the Center to provide technical consultation for the plan. This assistance commenced in late FY82, continued in FY83, and was completed in FY84.

9. NUCLEAR POWER PLANT SEISMIC EVALUATION

a. In FY81, FY82, FY83, and FY84, NSWC provided structural expertise to the Nuclear Regulatory Commission (NRC) in the review of the Final Safety Analysis Report (FSAR) in conjunction with operating license applications at the following nuclear power plant sites: (1) Midland, Michigan; (2) Waterford, Louisiana; and (3) Commanche Peak, Texas. At the FSAR stage, the applicant describes with specific engineering data the design conclusions and details of Category I Structures, Systems, and Components. Demonstration of compliance to applicable NRC regulations and requirements in all aspects of design, analysis, fabrication, and erection of Category I Structures and Systems is a prerequisite for approval of the FSAR. Upon completion of the FSAR review, evaluation, and approval, the applicant receives an operating license for commercial plant operation. In addition to the FSAR reviews, NSWC also participated in safety reviews for the following types of plant designs: (1) a standard nuclear steam supply system plant design submitted by a vendor and (2) a standard Balance of Plant design submitted by a utility applicant/architect-engineering firm.

b. Specific NSWC support to NRC included:

- (1) reviewing and evaluating the FSAR in accordance with the NRC accepted criteria;
- (2) preparing preliminary safety evaluation reports;
- (3) consulting with applicants and NRC staff to discuss and resolve open issues and assess additional information submitted by the applicant;
- (4) auditing structural designs; and
- (5) preparing affidavits and testimonies involving Category I structures.

c. NSWC issued and completed a contract to Butler Analysis, Inc. to prepare a preprocessor program to convert an acceleration time history on a rigid base to a forcing time history distributed over a cylinder modeled first as a shell, then as a stick. A set of user instructions was delivered, and an executable program was tested on an NSWC computer.

d. NSWC issued and completed a contract to extend the use of NASTRAN in performing seismic analysis by the direct transient, modal transient, and direct frequency response methods. Within the constraints for dynamic modeling, the code will be capable of accepting the finite element specifications provided by the user, and yield displacement, accelerations, and element forces at specified points and time. Element stresses at the centroid of specified elements as a function of time can also be obtained. Deformed plots of structural response as well as X-Y plots of the stresses at specified points and times will also be provided. The final report will include a technical description of the code, the basic theory, and a users manual section.

10. HIGH ALTITUDE PARACHUTE DEPLOYMENT

a. NSWC provided technical expertise and engineering design coordination to NASA, Goddard Space Flight Center, for a high altitude parachute deployment (90km region) and recovery program. NASA uses parachute systems to make various scientific measurements around the world (e.g., Alaska, Norway, Peru). The various systems are tailored to particular test requirements, including in-flight recovery via aircraft snatch of the descending parachute. Center participation included support in the following areas:

- (1) modifications to parachute systems (redesign of panel attach points, installation of radial load lines, redesign of parachute riser to incorporate attach point for load lines, and design and installation of crown area load lines);
- (2) systems drawings and packing procedures and techniques;
- (3) flight test participation (with post-test analysis of unsuccessful recovery attempt, and recommended fixes); and

(4) parachute packing supervision. No failures have occurred since NSWC involvement began.

b. During FY84, NSWC also contributed information and assistance to the following industrial firms in the areas of aerodynamics, structures, packing, and deployment:

- (1) Hycor Corporation
- (2) Syndex Corporation
- (3) Tracor Corporation
- (4) Defense Systems, Inc.
- (5) Aerojet Ordnance Surveillance

c. NSWC sponsored and hosted a three-day course in parachute technology in October 1983. The purpose of the course, presented at no cost to attendees, was to present a systems approach to the design of aerodynamic decelerator (parachute) systems. Attendees included representatives from NASA, Navy, Army, Air Force, and private companies.

d. NSWC published the following reports related to parachute technology:

- (1) A View on the Cause of Parachute Instability, NSWC TR 83-28
- (2) A Theoretical View on the Stress Analysis of Fully Inflated Parachute Canopies, NSWC TR 84-204

11. UNIVERSITY RESEARCH ASSIST

NSWC participates in a continuing cooperative effort with the Catholic University of America by providing Van de Graff accelerator and computer assistance for the development of an improved data base and predictive capabilities in heavy ion stopping powers and ion-induced K-shell ionization probabilities. The effort has applications in materials modification through ion implantation and surface layer alloying, and ion materials analysis through ion-induced X-ray production. This project terminates at the end of FY84.

12. GULF STREAM ACOUSTIC EFFECTS

NSWC supported the National Oceanographic and Atmospheric Administration (NOAA) and the University of Miami at the NSWC Ft. Lauderdale Test Facility. The support included providing building space, utility services, and manpower assistance. NOAA installed a computer controlled data acquisition system in an oceanside structure at the Ft. Lauderdale Facility. NSWC personnel emplaced a transducer on an underwater cable so that NOAA/university researchers could monitor gulf stream current effects on acoustic signals. This transducer was recovered in FY84.

13. COLLEGE COMPUTER SCIENCE PROGRAM

In May 1981, an NSWC technical staff member was detailed as a full-time faculty member to Mary Washington College (MWC) in Fredericksburg, Virginia, for one year. He significantly contributed to the computer science program at MWC in teaching and curriculum development. At the request of MWC, his assignment was extended for the academic year ending May 1983.

14. COMPUTER SCIENCE RESEARCH CONSORTIUM

The Computer Science Department at the Virginia Polytechnical Institute and State University (VPI/SU) has formed a Computer Science Research Consortium (CSRC) program to strengthen existing professional relationships and create new ones between VPI/SU professors and the Government and industry technical user community. NSWC is a member of this consortium and provides a representative for the CSRC's steering committee. Mutual benefits of the program include:

- a. providing a resource of quality graduates to academia, industry, and Government;
- b. promoting Government/academia personnel exchanges;
- c. providing feedback for orienting teaching requirements toward real-life applications;
- d. providing an increased awareness of outside requirements to help focus academic research efforts.

15. SYSTEMS RESEARCH CENTER AT VPI/SU

Effective 1 October 1983, NSWC co-signed a Memorandum of Understanding with NAVSEA and VPI/SU to establish a Systems Research Center at the University, which will be under NAVSEA sponsorship. The Systems Research Center will conduct research jointly with and in support of the scientific staff at NSWC. The research activities will add to the scope and breadth of the university's research program and produce additional equipment and educational opportunities for both faculty and students. The Government will benefit by strengthening and expanding the association of the Navy (NAVSEA and NSWC) and VPI/SU through a joint effort to support computer science and computing technology, recognizing their importance in modern naval applications.

16. TOURMALINE GAGES

a. The original tourmaline gage was designed and developed under Navy contract at Woods Hole Oceanographic Institute during WW II. These gages are used in the measurement of shock wave phenomena from underwater explosions. After the war, scientists formed Crystal Research Company to market the gage; the company closed in 1972. NSWC purchased the company assets and began producing gages to fill the void left by the defunct company. Improvements have been made to the gages in relation to evolving technology.

b. NSWC constructs and calibrates the gages which are sold at fixed price to various Government and industry research activities. Gages and related information are exchanged with foreign governments with whom the U.S. has information exchange agreements. Gage purchasers included the Department of Interior (Bureau of Mines); Elda Trading Corp.; Battelle; IREECO Chemicals; Gulf Oil Chemicals; Nitrochem Energy Corp.; and Safety Consulting Engineers.

17. HYDROGEN GAS GENERATOR

Based on previous NSWC experience in the development of hydrogen gas generators as power supplies for actuators and fluidic sequencers, the Department of Interior, Geological Survey funded NSWC to develop such a power supply for an underwater cavitation erosion gun which could be used for cleaning off-shore structures used for oil exploration. A prototype generator was developed in FY82. FY83 effort was limited to test preparations and material procurement due to funding limitations. Feasibility testing was completed in FY84 and the results were provided to the Department of Interior.

18. POSITRON LIFETIME STUDY

This research study, funded by NASA (Langley Research Center), was directed toward nondestructive evaluation of composite materials; it involves the extension of the technique from the study of fatigue in metals to the study of moisture in polymer resins. Positrons emitted from a suitable radioactive source enter a specimen of resin matrix composite or other polymeric material, and interact with negative electrons in the host material to produce annihilation gamma rays. The time between positron injection and emission of gamma rays (on the order of a few nanoseconds) has been shown to be dependent on the amount of absorbed moisture in the specimen. This technique is being studied for potential use in monitoring environmentally absorbed moisture (in resin-matrix composites) that can affect mechanical properties. The effects of chemical additives (such as metal ion complexes) on the water absorption processes in polymers is also being studied using the positron lifetime technique. NSWC provided data acquisition and data analysis support in FY81, FY82, FY83, and FY84. Results of recent work are published in Nuclear Instruments and Methods, Vol. 221, No. 2, 1 April 1984.

19. EXPLOSIVE TRANSFER LINES EVALUATION

a. NSWC has participated in a service life evaluation program conducted on rigid explosive transfer lines used to initiate aircraft emergency crew escape functions for a wide variety of military and NASA aircraft. The purpose of the program, sponsored by NASA (Langley Research Center), was to determine quantitatively the effects of service, age, and degradation on rigid explosive transfer lines to allow responsible and conservative service life determinations. Service life extension provides the opportunity for considerable cost savings of aircraft crew escape systems.

b. NSWC performed chemical characterization of HNS and DIPAM explosives contained in shielded mild detonating cords and flexible linear shaped charges using high performance liquid chromatography, scanning electron microscopy, and macrophotography. To date, 114 transfer lines have been evaluated under this program. NASA published a report of this work in NASA Technical paper #2143.

20. IMPACT SENSITIVITY TESTS

NSWC provides explosive facilities testing support to other Government agencies and industry. In FY83, the Department of Energy (Lawrence Livermore National Labs) funded NSWC to conduct impact tests to determine the sensitivity of various explosives.

21. PROMPT GAMMA TESTING OF ELECTRONICS

NSWC provides prompt gamma irradiation testing services to Federal agencies and private industry, as well as providing consultation on electronics hardening against nuclear radiation. New high-density, integrated electronics are particularly susceptible to ionizing radiation from nuclear sources. Prompt gamma is very effective in upsetting digital electronics such as microprocessors and computers. Designers use a variety of approaches to harden against these effects. Testing circuits, components, and materials in representative environments is an integral part of the design process. In FY81, FY82, FY83, and FY84, NSWC provided such testing support to several Government and industry organizations.

22. RADIOGRAPHIC INSPECTION OF FUEL CELL INSULATORS

The Brunswick Corporation funded NSWC in FY81, FY82, FY83, and FY84 to perform radiographic inspection in the nozzle/fuel cell bonding area of the space shuttle propulsion system. Specifically, this involves the rubber liners for the shuttle oxidizer tanks. A double-film, two-level exposure technique is used to assess the bond at specific intervals around the periphery of the assemblies.

23. UNDERSEA WEAPONS TANK

NSWC provides an underwater testing facility for the use of Federal agencies and industry. The Undersea Weapons Tank is 50 feet in diameter and 100 feet deep. A major feature is the retrieving platform or false bottom, operating to the 100 foot depth and providing quick recovery of the test units. There are six viewing platforms around the outside of the tank. During FY83 and FY84, test services were supplied to NOAA to support polluted water diving tests, and to a number of contractors who used the facility to test various systems.

24. HYDROACOUSTIC FACILITY SERVICES

NSWC's Brighton Dam Hydroacoustic Facility provides technical support and services to other government activities and private concerns for underwater equipment testing and analysis. In FY83, NSWC supported NOAA in conducting acoustic measurements and directivity patterns on an instrument used to determine underwater current profiles. NSWC also conducted underwater acoustic measurements on equipment for Applied Hydroacoustic Research, Inc.

25. MANUFACTURE OF EXPLOSIVE ELEMENTS

NSWC accepted a task to manufacture a limited quantity of tetryl pellets for the Department of Energy in FY84.

26. NBS SPUTTER STANDARDS

A cooperative effort between NSWC and NBS was undertaken in FY84 to produce sputtering standards for distribution to the scientific community. NBS prepared the multilayered Cr/Ni structures, and NSWC conducted the nondestructive analysis using Rutherford Backscatter Spectrometry to characterize the structures to determine the reliability and reproducibility of the preparation techniques. The NSWC analysis was performed on the Center's 2.5 MV Van de Graaff accelerator. The standards produced are soon to be released for use by scientists and engineers who use sputtering for materials analysis or for thin film preparation and etching.

27. DOT CONTAINER TESTS

At the request of the Department of Transportation, NSWC performed test and evaluation of specified hazardous shipping containers to determine their suitability in meeting DOT specifications for special shipping containers. The work (performed in FY81, FY82, and FY83) consisted of drop tests, repeated impact tests, dimensional checks, and pressure and strength tests. Test results have been reported to DOT.

28. MAGNETIC MEASUREMENTS

NSWC operates a Magnetic Structures Test Facility which is available to support specialized requirements of other Government activities and private industry. In FY83, a Honeywell-funded project involved eddy current measurements on aluminum plates using a cesium vapor magnetometer and a spectrum analyzer. The data were required by Honeywell for empirical verification of an analytical method to compute eddy currents.

29. PHOTOGRAPHIC SERVICES

Under a support agreement with the National Bureau of Standards, NSWC performed diagnostic and repair services on a high-speed camera. NSWC also provided use of a movie film processor on an interim basis.

30. CONSTRUCTION PHOTOGRAPHY

NSWC provided photographic services for the Department of Energy in FY84 to document key construction stages of a new explosive research facility at NSWC.

NSWC MP 85-58

APPENDIX B

NSWC FY83/84 TECHNOLOGY APPLICATION ASSESSMENTS

TECHNOLOGY APPLICATION ASSESSMENT

Date: 9/30/83
 CUFT #: _____
 LAB #: NSWC-TAA-83-001

1. Laboratory Naval Surface Weapons Center

Descriptors: Thermostat:
Electronic

2. Contact (ORTA) Ramsey D. Johnson
 Phone 394-1505 Autovon 290-1505
(301)

3. Address Silver Spring, MD 20903-5000 (Code D21)

4. Technology Name Electronic Thermostat

Applications: Thermostatic
switching

5. Technology Type: (a) Process (b) apparatus
 (c) material (d) service (e) study
 (f) other: _____

6. Users (a) Federal Government (b) State
 Government (c) Local Government (d) Small
 ind. (e) Medium ind. (f) Large ind. (g) Consultant
 (h) other: _____

7. Potential Support: exclusive license, consulting, joint venture,
 drawings, tooling, computer prog., economic study, training, adaptive eng.,
 other: _____

8. What Problem Does It Solve and How? Mechanical thermostats (using tempera-
ture sensitive metal alloys) are subject to contact deterioration and malfunc-
tion and are also susceptible to shock and vibration environments. The electronic
thermostat contains no moving parts and is not subject to these disadvantages.
The device uses the voltage/temperature relationship of a silicon semiconductor
together with an OP-AMP comparator and logic gate. It provides a digital control
signal for control of equipment using standard digital logic levels.

9. Other Uses: Unidentified

10. Main Advantages: Reliability

11. Production Information: Can be assembled with off-the-shelf, low-cost
components using normal laboratory equipment and facilities.

12. Descriptive Literature: U.S. Patent #4,137,770

13. Literature Available From: Patent Office and NSWC ORTA

Date: 9/30/83
CUFT #:
LAB #: NSWC-TAA-83-001

TECHNOLOGY APPLICATION ASSESSMENT

14. Description

Electronic Thermostat

A design for an electronic thermostat, capable of generating a digital control signal, has been patented (U.S. Patent #4,137,770) at NSWC. Made specifically for use in situations where the power supply is limited, this thermostat is unique from other commercial electronic sensing devices currently available for use in normal power supply situations. It is particularly useful in applications where high reliability under adverse conditions, such as shock or vibration, is required.

Thermostats used to control the operation of machinery and equipment have generally been designed around a mechanical means for temperature sensing. One example would be strips of metal alloys configured to trigger a switch as they expand and contract in response to changes in temperature. With repeated use encountered during industrial applications, the contacts of such switches tend to deteriorate and malfunction.

The electronic thermostat designed at NSWC does not contain mechanical parts and is not subject to these disadvantages. A silicon junction diode is used as one element of a resistance bridge to form the thermostat's temperature sensing element.

Furthermore, because controls for most machinery and equipment now use standard digital logic levels, the NSWC thermostat is designed to provide a digital control signal. Used in conjunction with a voltage comparator circuit having positive feedback, the control signal is provided whenever the temperature of the sensing element rises above a preselected value.

The patent on the electronic thermostat developed at NSWC is available for either exclusive or nonexclusive licensing. The concept has been incorporated into a U.S. Navy weapon component now in production.

TECHNOLOGY APPLICATION ASSESSMENT

Date: 9/30/83
 CUFT #: _____
 LAB #: NSWC-TAA-83-002

1. Laboratory Naval Surface Weapons Center

Descriptors: Magnetostric-
tion trans-
ducers

2. Contact (ORTA) Ramsey D. Johnson
 Phone 394-1505 Autovon 290-1505
(301)

3. Address Silver Spring, MD 20903-5000 (Code D21)

4. Technology Name Magnetomechanical Transducer

Applications: Transducers:
Magnetic valves;
Actuators:
Vibration control

5. Technology Type: (a) Process ☒ (b) apparatus
☒ (c) material (d) service (e) study
 (f) other: _____

6. Users ☒ (a) Federal Government (b) State
 Government (c) Local Government (d) Small
 ind. ☒ (e) Medium ind. ☒ (f) Large ind. (g) Consultant
 (h) other: _____

7. Potential Support: exclusive license, consulting, joint venture,
 drawings, tooling, computer prog., economic study, training, adaptive eng.,
 other: _____

8. What Problem Does It Solve and How? Improved magnetostrictive materials
deliver high mechanical strains (approx. 1500 ppm) under heavy loads. This
material can be energized rapidly by an external magnetic field. A
magnetostrictive flow control device has been patented which provides a less
complicated valve mechanism for precise and rapid microliter flow control.
General application is for microvalves, actuators, and positioners.

9. Other Uses: Flow control for use in mass spectrometers; for supplying
anesthesia gases; for blending fuels in process control systems.

10. Main Advantages: Extremely high strain, high force capability

11. Production Information: Currently manufactured at Ames Laboratory, Iowa
State University, Ames, Iowa

12. Descriptive Literature: "Magnetostrictive RFe₂ Compounds" Vol. I,
Ferromagnetic Materials, ed., F.P. Wohlforth, North-Holland (1980)

13. Literature Available From: A.E. Clark, Code R45, Naval Surface Weapons Center
10901 New Hampshire Avenue
Silver Spring, MD 20903-5000
Phone (301)394-1313

Date: 9/30/83
CUFT #: _____
LAB #: NSWC-TAA-83-002

TECHNOLOGY APPLICATION ASSESSMENT

14. Description

Magnetostrictive Flow Control Valve

Improved magnetostrictive materials are incorporated in a new electro-mechanical transducer patented (U.S. Patent #4,158,368) at NSWC for use as a fluid-flow control device.

Simple in design and operation, the flow control device is comprised of a cylindrical housing made from magnetostrictive materials with an electrical coil encircling its longitudinal axis. A tapered plunger, which exhibits negative magnetostriction, is placed within the housing along its longitudinal axis and seated with a discharge port. A magnetostrictive material is one that changes shape when placed in a magnetic field.

The improved magnetostrictive alloys used in this device are generally ternary mixtures of two heavy rare earths, which include praseodymium, terbium, samarium, holmium, erbium, and dysprosium, in combination with iron.

When an electrical current is passed through the coil, the magnetically sensitive materials in the housing expand relative to the plunger and cause the plunger to pull away from its seated position, thus opening the discharge port.

This flow control device design, which is available for licensing, provides a less complicated valve mechanism needed, for example, for precise and rapid microliter flow control, for use in mass spectrometers, for supplying anesthesia gases, or for blending fuels in process control systems.

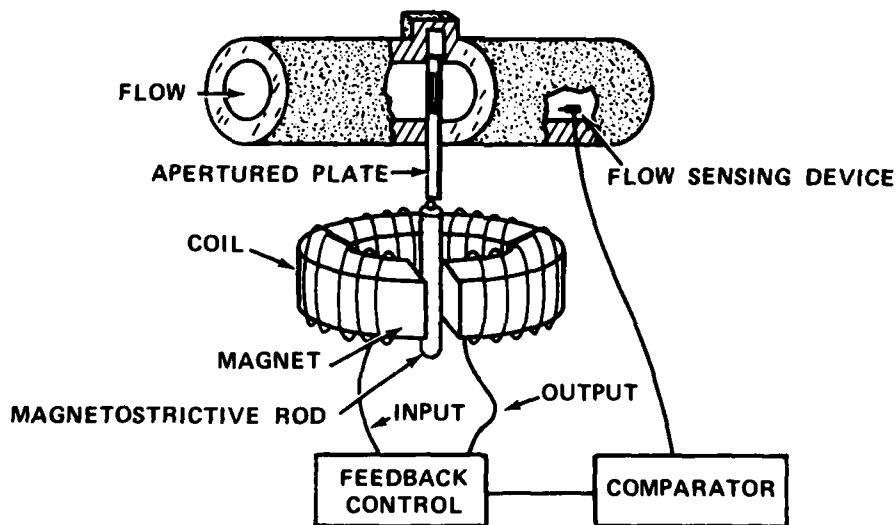


DIAGRAM OF MAGNETOSTRICTIVE FLOW CONTROL VALVE IN A FEEDBACK SYSTEM

TECHNOLOGY APPLICATION ASSESSMENT

Date: 9/30/83
CUFT #: _____
LAB #: NSWC-TAA-83-003

1. Laboratory Naval Surface Weapons Center

2. Contact (ORTA) Ramsey D. Johnson
Phone 394-1505 Autovon 290-1505
(301)

3. Address Silver Spring, MD 20903-5000 (Code D21)

4. Technology Name MHD Analogy Instrument

5. Technology Type: (a) Process (b) apparatus
(c) material (d) service (e) study
(f) other: _____

6. Users (a) Federal Government (b) State
Government (c) Local Government (d) Small
ind. (e) Medium ind. (f) Large ind. (g) Consultant
(h) other: Educational institutions

7. Potential Support: exclusive license, consulting, joint venture,
drawings, tooling, computer prog., economic study, training, adaptive eng.,
other: _____

8. What Problem Does It Solve and How? Simulation of supersonic flow in a
liquid, such as water. An analogy instrument for the measurement of underwater
shock waves and their interaction with submerged bodies. The instrument allows
accurate simulation of supersonic flow in liquids without requiring large tank
facilities.

9. Other Uses: Laboratory demonstration of underwater shock waves and their
interaction with boundaries.

10. Main Advantages: Low cost; rapid results; easy to use

11. Production Information: Low risk/low cost technology, materials and
fabrication techniques

12. Descriptive Literature: Navy Technical Disclosure Bulletin, Vol. 8, No. 1,
Sep 1982

13. Literature Available From: NSWC ORTA: Ramsey D. Johnson (301)394-1505

Descriptors: MHD;
Magnetohydro-
dynamic Analogy;
Shock;
Supersonic;
Underwater

Applications: Shock waves
in water; super-
sonic flow field
measurements in
water

Date: 9/30/83
CUFT #: _____
LAB #: NSWC-TAA-83-003

TECHNOLOGY APPLICATION ASSESSMENT

14. Description

Magnetohydrodynamic Analogy Instrument

NSWC has developed an instrument for studying supersonic flow in a compressible or liquid medium using the hydraulic analogy technique. The instrument is comprised of a tank holding a shallow layer of mercury through which a model under study traverses. An external magnetic field and current flowing through the mercury are adjusted to induce a force on the mercury simulating the property specific heat ratio or TAIT equation-of-state exponent.

The instrument allows extending the water table hydraulic analogy to specific heat values less than 2.0, and to TAIT equation exponent values greater than 2.0. The instrument, therefore, allows accurate simulation of supersonic flow in both compressible gas and liquids without building large wind tunnels and tanks.

A description is provided in the Navy Technical Disclosure Bulletin (Vol. 8, No. 1, Sep 1982) under Navy Case No. 66234.

TECHNOLOGY APPLICATION ASSESSMENT

Date: 9/30/83
 CUFT #: _____
 LAB #: NSWC-TAA-83-004

1. Laboratory Naval Surface Weapons Center

Descriptors: Analogy
Testing
Shock
Supersonic
Gas

2. Contact (ORTA) Ramsey D. Johnson
 Phone 394-1505 Autovon 290-1505
(301)

3. Address Silver Spring, MD 20903-5000 (Code D21)

4. Technology Name Hydraulic Analogy
Test Instrument

Applications: Shock waves in
gas; supersonic
flow field mea-
surements in gas

5. Technology Type: (a) Process (b) apparatus
 (c) material (d) service (e) study
 (f) other: _____

6. Users (a) Federal Government (b) State
 Government (c) Local Government (d) Small
 ind. (e) Medium ind. (f) Large ind. (g) Consultant
 (h) other: Educational institutions

7. Potential Support: exclusive license, consulting, joint venture,
drawings, tooling, computer prog., economic study, training, adaptive eng.,
 other: _____

8. What Problem Does It Solve and How? Simulation of supersonic flow in a gas,
such as air. An analogy instrument for the measurement of shock waves in gases
and their interaction with immersed bodies. The instrument permits accurate
simulation of supersonic flows without the need of large wind tunnels.

9. Other Uses: Laboratory demonstration of shock waves in gases and their
interactions with boundaries.

10. Main Advantages: Low cost; rapid results; easy to use

11. Production Information: Low risk/low cost technology materials and
fabrication techniques

12. Descriptive Literature: Patent Application No. 6378161 (5/14/82)

13. Literature Available From: NTIS, No. AD-D009574/5

Date: 9/30/83
CUFT #: _____
LAB #: NSWC-TAA-83-004

TECHNOLOGY APPLICATION ASSESSMENT

14. Description

Hydraulic Analogy Instrument for Gasdynamic Flows

NSWC has developed an instrument for studying supersonic flow in gases using the hydraulic analogy technique. The instrument is comprised of a tank holding a shallow layer of heavy liquid, such as mercury, covered by a layer of light liquid, such as water. A test model is moved along the bottom of the tank through the lower liquid, producing a wave pattern at the interface between the two immiscible liquids. The wave propagation speed of waves on the interface between the two liquids can be selected by choice of thicknesses and mass densities of the two liquids. Therefore, it is possible to simulate the speed of sound of most gases of practical interest.

The instrument allows extending the water table analogy to specific heat ratios in the range 1.0 to 2.0, and permits accurate simulation of supersonic flows without the need of large wind tunnels. Also, the technique can be used to simulate blast waves from explosions, and their interaction with targets.

A patent application (Serial No. 6378161) was filed on 14 May 1982.

9/30/83

TECHNOLOGY APPLICATION ASSESSMENT

Date: _____
 CUFT #: _____
 LAB #: NSWC-TAA-83-005

1. Laboratory Naval Surface Weapons Center

2. Contact (ORTA) Ramsey D. Johnson
 Phone 394-1505 Autovon 290-1505
(301)

3. Address Silver Spring, MD 20903-5000 (Code D21)

Radiographic
 4. Technology Name Nondestructive Evaluation

5. Technology Type: ☒ (a) Process ☐ (b) apparatus
☒ (c) material ☐ (d) service (e) study
 (f) other: _____

6. Users ☒ (a) Federal Government (b) State
 Government (c) Local Government (d) Small
 ind. (e) Medium ind. ☐ (f) Large ind. ☐ (g) Consultant
☒ (h) other: American Society for Testing Materials (ASTM)

7. Potential Support: exclusive license, consulting, joint venture,
drawings, tooling, computer prog., economic study, training, adaptive eng.,
 other: R&D

8. What Problem Does It Solve and How? This is a nondestructive test method
for evaluating flaws and discontinuities in all types of materials. Radiography
solves the problem of inspecting materials without destroying product
usefulness. This inspection method is accomplished by X-rays penetrating an
object, and thus producing a permanent visible photographic record of the
internal appearance and condition of the object.

9. Other Uses: Detects missing and unsafe components. Detects the condition
of materials before and after vibration testing, heat and humidity testing, drop
tests, etc.

10. Main Advantages: Radiographic testing does not destroy product
usefulness, and a visible permanent film record of the internal condition of an
object is produced.

11. Production Information: X-ray film is expensive; special skills and
technology are required.

12. Descriptive Literature: Books on the fundamentals and uses of industrial
radiography

13. Literature Available From: Technical libraries

Descriptors: Radiographic
Nondestructive
Evaluation;
Radiographic
Testing;
Radiographic
Inspection

Applications: R&D Evaluation
of: thin plastics and
aluminum, steel structures
up to 12" thick, graphite-
aluminum composites,
Batteries (all types),
explosives (up to 10 lbs),
electronic components, and
missile components

Date: 9/30/83
CUFT #:
LAB #: NSWC-TAA-83-005

TECHNOLOGY APPLICATION ASSESSMENT

14. Description

NSWC's Radiographic Facility

NSWC's fully equipped radiographic facility at White Oak, Silver Spring, MD, provides full-spectrum capability for the radiography of materials and structures. Capabilities extend over a broad range from 10 keV microfocus to 10 MeV.

With highly specialized personnel and equipment, the facility has the capacity to evaluate very thin plastics and aluminum; and, on the other end of the scale, it is capable of generating X-rays that can penetrate up to 12 inches of steel. Interpretive results range from minute discontinuities in very thin materials to flaws in the steel welds of submarines.

In this facility, numerous radiographic standards have been developed and are maintained for welds associated with various metals. Its R&D efforts in penetrometers or image quality indicator studies are known worldwide. At the Center, personnel conducted experiments aimed at developing a method for evaluating and classifying X-ray films and pursued a technique for curing explosive binders with high-energy X-rays.

R&D work conducted here not associated with radiographs includes a fuze inspection system that uses realtime X-ray gauging technology to reject defective fuzes in a production environment.

Applications

- o Quality Assurance Standards for Navy equipment
- o Radiographic standards for both thin and thick welds
- o Activation point studies of Lithium batteries
- o On-line radiographic control of automated fuze systems
- o Metal Matrix Composite NDE technology

TECHNOLOGY APPLICATION ASSESSMENT

Date: 9/28/84
 CUFT #: _____
 LAB #: NSWC-TAA-84-001

1. Laboratory Naval Surface Weapons Center

Descriptors: Nickle electrodes;
Composites;
Lightweight;
Energy density

2. Contact (ORTA) Ramsey D. Johnson
 Phone 394-1505 Autovon 290-1505
(301)

3. Address Silver Spring, MD 20903-5000 (Code D21)

4. Technology Name Lightweight Nickel Electrodes Applications:

5. Technology Type: ☒ (a) Process (b) apparatus
☒ (c) material (d) service (e) study
☐ (f) other: _____

Batteries;
Nickel-cadmium;
Nickel-zinc;
Nickel-hydrogen;
Nickel-iron

6. Users ☒ (a) Federal Government (b) State
 Government (c) Local Government ☒ (d) Small
 ind. ☒ (e) Medium ind. ☒ (f) Large ind. (g) Consultant
 (h) other: _____

7. Potential Support: exclusive license, consulting, joint venture,
 drawings, tooling, computer prog., economic study, training, adaptive eng.,
 other: _____

8. What Problem Does It Solve and How? Sintered nickel battery electrodes are
heavy and expensive to produce. NSWC has developed a nickel electrode that is
lightweight. Test results show that this electrode has a gravimetric energy
density approaching twice that of commercial sintered electrodes.

9. Other Uses: None

10. Main Advantages: Lower cost to produce and higher gravimetric energy
density.

11. Production Information: Medium capitalization cost required.

12. Descriptive Literature: Reports and Journal articles

13. Literature Available From: W. A. Ferrando, NSWC, R32 (301)394-3527

Date: 9/28/84
CUFT #: _____
LAB #: NSWC-TAA-84-001

TECHNOLOGY APPLICATION ASSESSMENT

14. Description

Lightweight Nickel Composite Electrode

a. State of Development: This represents a five-year basic research effort during which many successful single and multi-electrode prototypes have been fabricated and cycle tested. Both nickel cathodes and cadmium anodes have been successfully fabricated using the composite electrode structure. Cell endurance approaching 1000 continuous cycles at high charge, discharge rates have been demonstrated. Electrode gravimetric energy densities of 190 amp hours/kilogram have been achieved in these tests. Composite electrode plaque substrates have been produced industrially on a pilot basis. Active material impregnation procedures have been greatly simplified by a new method.

b. Applications: Secondary alkaline storage batteries

c. Patent Status:

(1) Patent No. 4,215,190 issued 1980, "Lightweight Battery Electrode." The electrode structure is available for license.

(2) Patent Disclosure (Navy Case No. 67,676), "A Suspension Impregnation Method." This method will be available for license.

d. Publications:

(1) "Cycle Life Characteristics of Composite Nickel Electrodes," Proc. of the Symposium on the Nickel Electrode, Vol. 82-4 Ed by R. G. Gunther and S. Gross, The Electrochemical Society, Inc., 10 South Main St., Pennington, NJ 08534

(2) "Surface Studies of Nickel Graphite Composite Battery Electrodes," W. W. Lee et al, Ibid

(3) "Cycling Tests on Multiplate Composite Electrode Ni-Cd Cells" Extended Abstracts of Battery Division Fall Meeting (1982), The Electrochemical Society, Inc., 10 South Main St., Pennington, NJ 08534

(4) "A Lightweight Nickel Composite Electrode: Concept and Feasibility," Journal of Power Sources, Vol. 12, 1984, pp. 249-265

e. Technical Information Contact: Contact Dr. William Ferrando, Code R32, NSWC, phone (202)394-3527

TECHNOLOGY APPLICATION ASSESSMENT

Date: 9/28/84
 CUFT #: _____
 LAB #: NSWC-TAA-84-002

1. Laboratory Naval Surface Weapons Center

Descriptors: Eddy Current:
Nondestructive
Inspection:
Graphite Epoxy

2. Contact (ORTA) Ramsey D. Johnson
 Phone 394-1505 Autovon 290-1505
(301)

3. Address Silver Spring, MD 20903-5000 (Code D21)

4. Technology Name Eddy Current NDI of
Graphite Epoxy

Applications: In-Service
Inspection of
Graphite Epoxy
Component

5. Technology Type: (a) Process (b) apparatus
 (c) material (d) service (e) study
 (f) other: _____

6. Users (a) Federal Government (b) State
 Government (c) Local Government (d) Small
 ind. (e) Medium ind. (f) Large ind. (g) Consultant
 (h) other: Organizations involved in in-service inspection of graphite epoxy.

7. Potential Support: exclusive license, consulting, joint venture,
drawings, tooling, computer prog., economic study, training, adaptive eng.,
other: _____

8. What Problem Does It Solve and How? The increasing use of advanced
composite materials such as graphite epoxy requires the development of field
applicable non-destructive methods to assess the structural integrity of
components of those materials. Eddy current offers a low cost, automated
inspection system which could complement and, in some cases, replace ultrasonics
in the in-service inspection of certain such components.

9. Other Uses: N/A

10. Main Advantages: Inexpensive, easy to use, fast, automated

11. Production Information: Eddy current technology is highly developed and
requires only modification for application to graphite epoxy.

12. Descriptive Literature: See below

13. Literature Available From: S. N. Vernon, (301)394-1029, NSWC, Code R34
 12. a. Vernon, S. N. and Paul M. Gammell, "Eddy Current Inspection of Broken
Fiber Flaws in Non-metallic Fiber Composite," Proceedings of the Review
of Progress in Quantitative NDE, University of Calif., San Diego, La
Jolla, CA, 8-13 July 1984.

b. Vernon, S. N., "Detection and Measurement of Broken Fiber Type Defects
in Graphite Epoxy Using Eddy Current Methods," to be published in
Nondestructive Testing Communications.

Date: 9/28/84
CUFT #: _____
LAB #: NSWC-TAA-84-002

TECHNOLOGY APPLICATION ASSESSMENT

14. Description

Eddy Current Non-destructive Inspection of Graphite Epoxy

The Naval Surface Weapons Center has demonstrated that eddy current technology can be used for the non-destructive inspection of graphite epoxy composite materials. Eddy current based non-destructive inspection systems are safe, fast, accurate, and require access to one surface only.

Both eddy current and ultrasonic methods of non-destructive inspection permit wide-area scanning of a material. However, eddy current technology has an advantage over ultrasonics because no couplant material is required to couple the energy to the material. Consequently, a structure can be eddy-current inspected in the field without submerging the structure in a tank of water or placing a jet of water between the probe and the materials.

Service incurred damage in graphite epoxy components such as wing skins and ailerons almost invariably involves broken graphite fibers. In spite of the very low conductivity of these fibers, eddy current methods are sensitive to their breakage. In addition, eddy current can determine the size of the region containing the broken fibers as well as the through-thickness location of this region. Research in the application of eddy current methods to graphite epoxy inspection is in the initial stages.

Publications:

(1) Vernon, S. N., and Gammel, Paul M., "Eddy Current Inspection of Broken Fiber Flaws in Non-metallic Fiber Composite," Proceedings of the Review of Progress in Quantitative NDE, held at University of California, San Diego, La Jolla, CA, 8-13 July 1984.

(2) Vernon, S. N., "Detection and Measurement of Broken Fiber Type Defects in Graphite Epoxy Using Eddy Current Methods," to be published in Nondestructive Testing Communications.

TECHNOLOGY APPLICATION ASSESSMENT

Date: 9/28/84
 CUFT #: _____
 LAB #: NSWC-TAA-84-003

1. Laboratory Naval Surface Weapons Center

Descriptors: NASTRAN
Seismic
Analysis
Nuclear

2. Contact (ORTA) Ramsey D. Johnson
 Phone 394-1505 Autovon 290-1505
(301)

3. Address Silver Spring, MD 20903-5000 (Code D21)

4. Technology Name Seismic Enhancements
in NASTRAN

Applications: Seismic analysis;
Shaker test
analysis;
Foundation shaking
analysis; Body
force acceleration

5. Technology Type: (a) Process (b) apparatus
 (c) material (d) service (e) study
 (f) other: Computer Program for Seismic Analysis

6. Users (a) Federal Government (b) State
 Government (c) Local Government (d) Small
 ind. (e) Medium ind. (f) Large ind. (g) Consultant
 (h) other: _____

7. Potential Support: exclusive license, consulting, joint venture,
drawings, tooling, computer prog., economic study, training, adaptive eng.,
 other: _____

8. What Problem Does It Solve and How? Provides NASTRAN with a 3-dimensional
structural analysis code with seismic capability for extended structures.

Seismic in this context means the disturbance to a structure arising from
varying accelerations applied at its base. Operates on Control Data Cyber
170-720 and VAX 11/780 computers.

9. Other Uses: (1) Simulated vibration testing to check out designs of
machines that are required to be qualified by shaker testing; (2) foundation
shaking analysis; (3) body force accelerations

10. Main Advantages: Provides analysts with considerably more comprehensive
information regarding structural responses to excitation sources.

11. Production Information: N/A

12. Descriptive Literature: Report on the Development of Seismic Analysis
Capability in NASTRAN

13. Literature Available From: (1) Ramsey D. Johnson, Code D21
Naval Surface Weapons Center
Silver Spring, MD 20903-5000
(301)394-1505
(2) NASTRAN Manual (future incorporation)

Date: 9/28/84
CUFT #: _____
LAB #: NSWC-TAA-84-003

TECHNOLOGY APPLICATION ASSESSMENT

14. Description

Seismic Enhancements in NASTRAN

Twelve new functional modules have been developed which augmented NASTRAN's (NASA Structural Analysis Program) dynamic capability to include the solution of seismic problems in a single step for the following five analysis routes:

- Direct Frequency Response
- Direct Transient Response
- Modal Frequency Response
- Modal Transient Response
- Design Spectrum Analysis

Seismic, in this context, means the disturbance to a structure arising from varying accelerations applied at its base. This new seismic capability will provide for solutions of structures subject to acceleration excitations. The Code will run on the Control Data Cyber 170-720 and VAX 11/780 computers. The development is completed and the new modules are being verified prior to final inclusion in NASTRAN.

This seismic capability is not limited to representations of extended structures by "stick models." Instead a full range of plate, shell, solid, and scalar elements are at the disposal of the analyst for determining detailed stress and acceleration response histories in any part of his structure in a single step. Costs of analyzing designs can be reduced by proceeding directly from a 3-D static analysis into a 3-D seismic analysis without having to remodel into a stick model and reprocess seismic results.

A corollary benefit of this seismic offering is its ability to be applied to problems other than earthquakes. Designs of machines that are required to be qualified by shaker testing can be checked by using this seismic analysis tool to simulate a vibration test on a shaker while the machine is still in the design stage before any manufacturing starts. Another application is to the analysis of a frequently occurring problem of vibration disturbances to foundations of rotating machines such as shipboard engines. Lastly, this can be applied to a time varying acceleration field such as centrifugal force or magnetic pulses.

TECHNOLOGY APPLICATION ASSESSMENT

Date: 9/28/84
 CUFT #: _____
 LAB #: NSWC-TAA-84-004

1. Laboratory Naval Surface Weapons Center

2. Contact (ORTA) Ramsey D. Johnson
 Phone 394-1505 Autovon 290-1505
(301)

3. Address Silver Spring, MD 20903-5000 (Code D21)

4. Technology Name Surface Roughness Technique

5. Technology Type: (a) Process (b) apparatus
 (c) material (d) service (e) study
 (f) other: Modeling technique

6. Users (a) Federal Government (b) State
 Government (c) Local Government (d) Small
 ind. (e) Medium ind. (f) Large ind. (g) Consultant
 (h) other: _____

7. Potential Support: exclusive license, consulting, joint venture,
drawings, tooling, computer prog., economic study, training, adaptive eng.,
 other: _____

8. What Problem Does It Solve and How? Calibration curves for chilled iron
grit and silicon dioxide grit provide a technique for predetermining pressure
setting and grit size needed to control grit-blasting for a prescribed surface
roughness on wind tunnel models. Predictive capability facilitates
repeatability of surface roughness and is especially useful in comparing results
from different tests and equipment.

9. Other Uses: N/A

10. Main Advantages: Predictive approach to control size and spacing for
obtaining desired roughness.

11. Production Information: N/A

12. Descriptive Literature: NSWC MP 83-444 (see below)

13. Literature Available From: Ramsey D. Johnson, Code D21
Naval Surface Weapons Center
Silver Spring, MD 20903-5000
(301)394-1505

12. NSWC MP 83-444, Grit Blasting a Distributed Roughness Based on a 30%
Probability of Exceedence, Oct 1983

Descriptors: _____
Surface Roughness
Models
Wind Tunnel

Applications: To produce
controlled surface
roughness on wind tunnel
models

Date: 9/28/84
CUFT #: _____
LAB #: NSWC-TAA-84-004

TECHNOLOGY APPLICATION ASSESSMENT

14. Description

Surface Roughness Technique

A surface roughness study was conducted at NSWC to obtain a prescribed roughness on a metal surface through control of a grit-blasting technique. The grit-blasting technique was used to generate a desired surface roughness height and distribution on wind tunnel models. This technique provides a predictive capability which facilitates obtaining repeatability of surface roughness. It is particularly advantageous in the preparation of models for comparing results from different tests and testing facilities. In contrast, the technique of bonding grit to a model is not easily controlled for duplicating a predetermined roughness, and boundary layer trip rings are difficult to attach in some applications.

Surface roughness is used on wind tunnel models as a boundary layer trip to produce turbulent flow over models which are tested at low Reynolds number conditions. It is also used to generate aerothermodynamic effects such as augmented heat transfer or skin friction. In each case, the exact character of the roughness must be known in order to compare results from different tests and facilities.

Calibration curves for #12 chilled iron grit and #20 silicon dioxide grit were obtained. Three metals--Stainless steel 17-4 PH annealed, stainless steel 17-4 PH heat treated to 1150°F, and nickel 200 annealed--were grit blasted at various pressure settings. The mechanical properties of stainless steel 17-4 PH annealed and heat treated to 1150°F were essentially the same and no noticeable differences were noted in the calibration curves. For a given pressure setting, a larger roughness value was obtained on the nickel samples. The curves will give a good approximation as to what pressure setting and grit size will be needed to obtain a prescribed surface roughness.

Over the range of pressure settings that were tested (20 psi to 100 psi), nearly linear correlations resulted. NSWC scientists felt that there is a threshold pressure above which the sample must be grit blasted before a surface roughness can be measured. Additionally, there is a maximum pressure above which no increase in surface roughness will be found.

NSWC MP 85-58

APPENDIX C

NSWC INVENTIONS AND PATENTS IN FY83/84

<u>TECHNOLOGICAL AREA</u>	<u>NAVY CASE OR PATENT NO.</u>	<u>TITLE AND PURPOSE</u>	<u>POTENTIAL COMMERCIAL APPLICATIONS</u>
1. Missile guidance system	65,821	A New Guidance Law to Improve the Accuracy of Tactical Missiles	Any canard controlled airframe would use the system
2. Metallurgy	65,305	Mixing of SiC Whiskers with Aluminum and Magnesium in a Eutectic Formation	Has great potential in high temperature aluminum-magnesium eutectic formation
3. Combustion chamber	63,318	Bi-planner Swirl Combustor	Combustion chamber for steam generator that makes 30-40% fuel savings
4. Semiconductors	59,648	Process for Preparing Isolated Planar Junctions in Thin-Film Semiconductors (Improved Method)	Semiconductor manufacture
5. Aeronautics	59,536	Adapter Assembly for Flat Trajectory Flights (for Unguided Projectiles)	Aeronautics
6. Fiber optics	63,442	Cable Connector (for Joining Optical Cables)	Communications
7. Spacecraft	60,606	Deployable Support Structure for Spacecraft (for Stowing During Launch)	Space launch vehicles
8. Aeronautics	57,697	Flat Trajectory Projectile	Aeronautics
9. Refrigerant containment	65,764	Method of Charging and Hermetically Sealing High Pressure Gas Container	Commercial satellites; Guidance
10. Radiation absorption	66,216	Neutron Radiation Shielding Material and Method of Preparation	Power plants; Nuclear processing
11. Radiation shielding	66,982	Radiation Source Shield and Calibrator	Power plants; Nuclear processing

<u>TECHNOLOGICAL AREA</u>	<u>NAVY CASE OR PATENT NO.</u>	<u>TITLE AND PURPOSE</u>	<u>POTENTIAL COMMERCIAL APPLICATIONS</u>
12. Ball bearings	4,364,170	Ball Bearings Assembly Device (Mechanism for Aiding Assembly of Ball Bearing Between Races)	Ball bearing manufacture
13. Magnetostrictive materials	65,888	Magnetomechanical Energy Conversion	Hydrophones; Pressure sensors
14. Magnetostrictive materials	4,378,258	Conversion Between Magnetic Energy and Mechanical Energy	Transducers; sonar; sound transmission elements; sonic delay lines; sonic filters
15. Explosives	4,372,213	Molten Metal-Liquid Explosive Method	Explosives
16. Materials testing	4,352,292	Instrument for Measuring Dynamic Viscoelastic Properties	Rubber shock absorbers
17. Conveyors	66,373	Load-Unload Sensor (Mechanism for Protecting Conveyor Overload)	Conveyors
18. Electrical power overcurrent	4,363,064	Overcurrent Protection System	Adaptable for use with power controllers of the single- or multi-phase AC or DC types
19. Electrical (semiconductor devices)	4,371,232	Graded Gap Semiconductor Device	A method of preparing epitaxial films for use as infrared detectors, lenses, and light emission devices
20. Electrical (semiconductor devices)	4,391,651	Method of Forming a Hyperabrupt Interface in a GaAs Substrate	Technique for creating a hyperabrupt interface between the electrical active and the underlying layer of a semiconductor substrate
21. Electrical (semiconductor devices)	4,380,774	High-Performance Microwave Transistor	Improved high frequency response coupled with increased power output in the microwave range

<u>TECHNOLOGICAL AREA</u>	<u>NAVY CASE OR PATENT NO.</u>	<u>TITLE AND PURPOSE</u>	<u>POTENTIAL COMMERCIAL APPLICATIONS</u>
22. Electrical (active and passive filters)	66,306	Semi-Active Notch Filter	Useful as a component in phase-locked-loops
23. Electrical (phase shifter)	66,061	An Electronic Phase Shifter Having a Constant Magnitude Output	Useful as a component in phase-locked-loops
24. Electrical (magnetometers)	4,384,254	Oscillator/Driver Circuit for Fluxgate Magnetometer	Useful as a component in a vehicle detector and in an intrusion detector, for example
25. Electrical (correlation device)	4,414,641	Digital M of N Corre- lation Device Having Increased Bit Rate	A digital correlation device which encom- passes a fast corre- lation product for pulse compression modulation such as phase or frequency shift keying
26. Electrical (laser device)	4,403,323	Optical Transistor	Adaptable for use in systems which perform detection and communication functions with light waves
27. Electrical (adaptive control device)	66,686	An Apparatus for and a Method of Controlling Multiple Time-Varying Processes	The apparatus can adapt to the changing environment and dynam- ics of a plurality of processes under its control so as to ensure an adequate level of control
28. Electrical (interceptive electrical probe)	67,862	A Coaxial Probe for Measuring the Current Density Profile of Intense Electron Beam	Useful for the mapping of the radial current density profile of high energy and high current electron beams
29. Bombs	4,405,100	Turbulence Generator for Maximizing Configu- ration Tolerances of Free Flight	None

<u>TECHNOLOGICAL AREA</u>	<u>NAVY CASE OR PATENT NO.</u>	<u>TITLE AND PURPOSE</u>	<u>POTENTIAL COMMERCIAL APPLICATIONS</u>
30. Radiation detection	4,409,485	Radiation Detector and Method of Opaquing the Mica Window	Radiation detection
31. Material testing	4,418,573	Method for Measuring Material Characteristics	Testing of elastic and acoustic materials
32. Shaped explosive charge and direction	4,418,622	Munroe Effect Breaching Device (Shaped Charge for Breaching Safes and Buildings)	Breaching strong structures
33. Gas cutting and welding	4,422,471	Four Bar Manifold (Gas Distribution for Cutting Torches)	Gas cutting torches
34. Ship hull cleaning	4,421,205	Magnetic Ship's Hog Line Holder (for use by workman in cleaning a ship's hull)	Use in shipyards and for ships at sea to clean or repair ship's hulls
35. Steam valves	4,438,782	Isolation Steam Valve with Atmospheric Vent and Relief Capability	Steam power plants and cargo ships
36. Hydraulics and aerodynamics	4,430,890	Two Layer Hydraulic Analogy for Testing Gas Flows with Shock Waves	Aviation manufacturing
37. Fire protection	4,434,855	Sprinkler Valve	Fire protection for ships and buildings
38. Radar	4,436,569	Method of Forming A Protective Cover For Aircraft Radomes	Commercial aviation
39. Semiconductors	4,406,050	Method for Fabricating Lead Halide Sensitized Infrared Photodiodes	Infrared detectors
40. Semiconductors	4,442,446	Sensitized Epitaxial Infrared Detector	Infrared detectors
41. Powder metallurgy	66,029	Method of Bonding Metal Carbides in Non-Magnetic Alloy Matrix	Security vaults, locks, wear resistant tools
42. Security devices	66,030	Padlock Shackle	Padlocks and locking devices

<u>TECHNOLOGICAL AREA</u>	<u>NAVY CASE OR PATENT NO.</u>	<u>TITLE AND PURPOSE</u>	<u>POTENTIAL COMMERCIAL APPLICATIONS</u>
43. Powder metallurgy	66,879	Method of Compacting Powders	Forming solid objects from Nitinol powders
44. Small boats	67,171	Trim Control for Tunnel Hulled Craft	Potential use on small boats for decreasing water drag to obtain higher operating efficiency
45. Radiation dosimeter	4,406,947	Calibrating Device for Ionizing Radiation Dosimeters	Inexpensive calibration device having wide application in radiation field
46. Preparation of CF_3NF_2	4,430,514	A Novel Method for the Preparation of CF_3NF_2	This is a very competitive process for preparing CF_3NF_2
47. Sampling of toxic chemicals	4,434,927	Penetrator Interface Adapter Concept	A novel device that is useful in sampling toxic chemicals
48. Shaped charges	66,826	Annular Shaped Charge and Method of Breaching Masonary Walls-to Selectively Blast Apertures in Masonary Walls	Reconstruction and rehabilitation of existing structures
49. New plasticizer for nitropolymers	4,457,791	New Plasticizer for Nitropolymers	A novel composition of matter useful in many chemical areas
50. Preparation of ceramic/glass composites for high temperature applications	67,111	Preparation of Ceramic/Glass Composites for High Temperature Structural Applications	The composites of this invention have many special applications in high temperature work
51. Combustion chamber	4,396,368	Bi-Planner Swiel Combustor	A device for converting fuel to power
52. Magnetic field detection using optical fibers	4,433,291	Optical Fiber for Magnetostrictive Response Detection of Magnetic Fields	Detection of magnetic fields or modulation of light

<u>TECHNOLOGICAL AREA</u>	<u>NAVY CASE OR PATENT NO.</u>	<u>TITLE AND PURPOSE</u>	<u>POTENTIAL COMMERCIAL APPLICATIONS</u>
53. Securement of a store to the body of an aircraft	4,440,365	Trapeze Store Launcher	Releasable storage of articles
54. Metallurgy	65,321	Consolidation of Ion Plates G/Al Mats into Sheets and Other Shapes	Sales of composite materials
55. Chemistry	66,064	Improved Process for Preparation of Dimethylmethylenedinitramine	Preparation of complex dinitramines
56. Electronics	65,648	Flicker Free Stretched Grams	Reduction of perception of Flicker
57. Aeronautics	65,647	Anvil-Strap Rotor	Increase of load handling capability of laminated rotors in helicopters
58. Electronic filters	4,464,637	Semi-Active Notch Filter	Invention is useful in PLL applications and allows independent control of the low-frequency phase shift and the high-frequency attenuation, i.e., the notch frequency

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